

ON THE
OPERATION OF TREPHINING

IN CASES OF

FRACTURE OF THE SPINE.

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IN the number of this Journal, published at this time last year, I offered some observations on a case of fracture of the spine in which I performed the operation of trephining. I briefly alluded in that communication to a case in which Dr. Gordon had performed this operation. Dr. Gordon's case, which has proved successful as regards the patient's life, was communicated to the Royal Medico-chirurgical Society of London in November last, and as the full details of it will be published in the forthcoming volume of the *Medico-chirurgical Transactions* I shall here only notice the leading features of it.

In my former communication I confined myself to a discussion of the general question as to whether the operation of trephining the spine should be adopted in certain cases, or whether it was to be set aside altogether as an operative procedure, as it practically has been for many years past. I am very well aware that not a few distinguished surgeons are of opinion that it should be set aside altogether; but I also know that there are many who coincide with me in thinking that this operation should be acknowledged in certain cases to be justifiable; that it should not be taught in our schools as a matter of course—that in all cases of fractured spine it is worse than useless, and not to be thought of; but, that the proceeding of trephining the spine should be permitted to take its

place among the legitimate operations of surgery as one which, although formidable, and in most cases not likely to prove successful, nevertheless offers, in certain cases, by far a better prospect of saving life than the system of doing nothing.

In the present paper I purpose to consider the special circumstances and symptoms which appear to indicate cases favourable for the operation, or the reverse; and finally the method of performing the operation in the different regions of the spine. Before, however, entering on the consideration of these topics I may be allowed to add a few observations in reply to some objections which have been raised to the operation of trephining the spine.

CASE I. (Dr. Gordon's Case).—Michael Clinton, a slight and well-made, although rather pallid and wasted, man, of thirty-one years of age, was admitted to the Whitworth Hospital, under Dr. Gordon's care, on May 30th, 1865. For some years he had been employed as an engineer on railways in the United States, and describes himself as having been an active, healthy person up to the 27th of March last, when he met with an accident of which he gives the following account:—While hunting, his horse shied at a fence, and he was flung off into a gripe on his back, which came in contact with some stones; immediately his lower limbs were paralysed; he made an effort to get up, but found that he was completely powerless from the waist down. He was carried home in great pain; for four or five days he had retention of urine, requiring the introduction of the catheter; at this period the distention of the bladder caused him acute pain; after this the urine began to dribble away; it became, as he says, "very offensive, and full of corruption-like matter."

From the first he had paralysis of the sphincter ani, with involuntary passage of feces. For five weeks after the accident he was not conscious of sensation in the lower limbs; he had occasional priapism.

After admission to hospital he was carefully examined; his condition at that time was noted as follows:—In the lower limbs muscular power is entirely lost so far up as the knees; except the sartorius, the muscles of the thigh have little or no power; he has no power over either the bladder or rectum.

Sensation is lost in both feet; from the ankle to the knee he feels obscurely, the left leg being almost devoid of sensibility. There

is hyperesthesia of each thigh—on the right side to so great an extent that he is distressed by rubbing the hand across the surface of it. Below the knee he cannot appreciate the difference between heat and cold: a vessel of warm water, which, applied to the left thigh, is of an agreeable temperature—when applied to the right causes him to cry out that he is burned. He can tell, without seeing them, the position in which the lower limbs are placed. No reflex movements can be excited in any of the muscles below the knees; in each thigh reflex motion can be readily aroused; on the right side the slightest touch of a hair, or even blowing on the surface causes vigorous contractions, especially of the sartorius muscle.

The lower limbs are considerably wasted; there is no œdema of the feet or ankles, which are bedewed with perspiration; the penis and scrotum are large and flabby, but not ulcerated; the orifice of the urethra is inflamed, it is not possible to introduce a double channelled silver catheter (size No. 10); a bed-sore, about the size of half-a-crown, has formed on the back; the urine is alkaline, very muddy and fetid, containing a copious muco-purulent deposit, and tinged with blood.

Upon examining the spinal column, the spinous process of one of the lower vertebræ was found to project considerably. This projection existed at a distance of four inches above a circle made round the body at the level of the umbilicus, and was not movable.

The nature of his case, and of the proposed operative procedure having been explained to the patient, the operation of trephining the spine was undertaken at his request, and was performed on June 3rd, 1865, the patient having been placed under the influence of chloroform. The operation lasted fifty minutes; the amount of blood lost was not considerable.

Fourth day after operation.—Urine became acid.

Fifth day after operation.—Urine again alkaline, scalds him in passing.

Eleventh day.—Had a motion from the bowels, of the passage of which he was perfectly conscious, but unable to control. Urine since last date alkaline; drawn off with catheter.

Fourteenth day.—Urine, when drawn off, acid, and quite free from blood.

Sixteenth day.—Urine slightly alkaline, and continued neutral for three days, when it became acid.

Twenty-sixth day.—Can eject the urine from the bladder; and

since the beginning of July the power over the bladder is such as to force the water strongly against the side of the vessel in a full stream, and on one occasion to a distance of between two or three feet; urine persistently acid; the catheter is no longer necessary.

Eight weeks after the operation the patient was able to go out into the open air, reclining on his back in a basket carriage. At this date the bed-sore on the back was quite well, and the wound healed; motion was in an appreciable degree restored in the lower limbs, and sensation much improved; the power over the bladder restored, and the condition of the urine almost natural; the patient's appearance much improved, and his appetite good; a minute portion of bone, weighing a couple of grains, had come away; no abscess had formed; he felt his back so strong that he desired to be allowed to sit up; he could turn himself from side to side readily, and with confidence.

Six months after the operation the report was as follows:—The patient can sit upright without the least discomfort, or feeling of weakness in the back; he makes water, he says, as well as ever he did; he cannot stand, or, of course, make an attempt at walking; and although by forcing he can evacuate the bowels, yet the sphincter ani has not regained its power.

Now (July 9th, 1866) the patient being unable to stand or walk, moves himself about in an invalid chair. He has sought employment as a worker at a steam lathe, at iron-works in the neighbourhood of Dublin.

I must congratulate my friend and colleague, Dr. Gordon, on the measure of success which has attended his operation in this instance. The case is one which will become classical—it has the merit of being, if not the first case of trephining of the spine which has been attended with success as regards the saving of life, recorded in the British Islands, at least the first fully and accurately reported. It has the value which is always attached to a case occurring in an hospital in a large city, and beneath the critical eyes of a large number of students and practitioners.

I conceive that no impartial person will deny that in this case the operative procedure and the improvement which followed it were related to each other as cause and effect. The diminution of hyperesthesia, and of the exalted reflex action—the improvement in the urine, bed-sore, and bladder—the increase of sensibility below the knees, as well as of motor power in the thighs, followed the

operation in such a way as to leave little doubt that they were due to it. It is possible, and even probable, that the subsidence of the hyperesthesia and exalted reflex action of the right thigh may have been due, not to the removal of the portion of bone causing pressure or irritation of the cord, but to the counter-irritation produced by the wound beginning to suppurate. This subsidence of hyperesthesia was the earliest sign of amendment, and in consequence of it the patient got great relief from a distressing symptom; but, possibly, active counter-irritation by blisters or issues might have produced a similar result. But this cannot be said for the disappearance of all muco-purulent deposit, and blood from the urine, and the healing of the bed-sore, with, by degrees, the returning acidity of the urine; the perfect power, also, which the patient now has over the bladder must, I conceive, in fairness be attributed to the operation. It is interesting to observe that this power became restored by steps just reversing the order in which it is lost in such cases. The water, instead of constantly dribbling away, became retained—the catheter became necessary for a time, and it gradually became possible to dispense with it altogether.

This case will, no doubt, be regarded very differently by various individuals; some will say, that after all it proves nothing more than that the operation is one not necessarily fatal, but that the patient would probably have made an equally good recovery if not operated upon. If, however, it be admitted that there is nothing in the operation necessarily fatal—if the case shows that extensive supuration and exfoliation, making convalescence very tedious, if not impossible, are not invariable attendants on the operation, a great step has been gained, and many of the most plausible arguments urged against the operation are answered by this alone. For my own part, however, I am convinced that the patient's life was saved by the operation; he thinks so himself also. He was getting gradually worse up to the time of the operation; after it he steadily improved up to a certain point. Having seen him before the operation, and watched him closely since, I can at least say that I have never met with any case presenting such symptoms as Clinton's, which did not certainly run a fatal course. On the other hand some persons will probably attach to this case even a greater importance than it deserves—that is to say, greater in comparison with cases which have had a less successful issue. They will in short pay the usual tribute to success, and estimate more highly the single fact,

that the patient is living twelve months after the operation, than the several facts revealed in a case where marked amendment in different symptoms took place; and yet a *post mortem* examination ultimately showed the exact nature of the injury, and the connexion between the amendment and the operation itself.

Although I am very sensible of the merits of Dr. Gordon's case, yet, I believe, that the instance in which I myself operated is, on this account, more instructive upon some points than his. I may be pardoned for briefly alluding to it:—

CASE II.^a—Joseph Collins, thirty-eight years of age, was admitted to Jervis-street Hospital on December 28th, 1864, having had his spine fractured by a sack of wheat falling upon him from a height; he had the usual symptoms which accompany this injury.

The posterior arch of the first lumbar vertebra was removed by operation, on February 3rd, 1865.

On the day following the operation a great improvement had taken place in the returning sensibility, and power of motion in the lower limbs. The bed-sores which had formed gradually made good progress; the penis and scrotum, which were œdematous and ulcerated, became reduced in size, and the ulcerations healed; the patient regained some power over the bladder.

He died on the 17th day after the operation, in consequence of abscesses having formed in the kidneys.

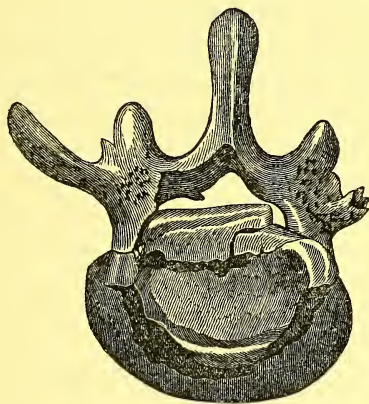
The *post mortem* examination also showed that the body of the first lumbar vertebra was fractured, and this vertebra was displaced backwards; the line of fracture separated only a small portion of the body of the broken vertebra. The intervertebral substance between the last dorsal and first lumbar vertebræ had been torn. The dura mater of the cord was uninjured; the portion of it corresponding to the piece of bone removed at the time of the operation was covered externally with lymph; the surface next the cord was healthy; there was no trace of inflammation within the dura mater. The cord was not inflamed or softened; it was indented at a point corresponding to where the bone was displaced.

Although in this case the operation would have been much more satisfactory if the posterior arch of the last dorsal vertebra had also been removed, yet what was done is sufficient to prove that where

^a For full details of the case, see the number of this Journal, August, 1865.

pressure on the cord is caused by fracture and displacement of the body of the vertebra, benefit arises from taking away the counter-pressure posteriorly; that, in short, removal of the counter-pressure in such cases is enough to enable the spinal cord, in a great degree, to resume its functions. Of course the fact that benefit is gained by taking away the posterior arches, when the cord is subject to compression, in consequence of fracture or displacement of the vertebral body—that motion and sensation in such cases, more or less, completely returns, and ulcerations heal—in short, the evidence thus offered, that the spinal cord, to a certain extent, recovers its powers is more conclusive than any theoretic argument that can be offered on the subject. The following experiment, however, suggested to me by my former pupil, Dr. Alexander Filson, makes very clear the precise mode in which the removal of the posterior arch may relieve pressure on the spinal marrow, even when arising from some cause acting on the anterior portion of the canal. Suppose that a short piece of Indian rubber tube, just large enough

Fig. 1.



to fill it, is introduced into the spinal canal, and the body of the vertebra then crushed or broken with a hammer, in such a manner as is shown in the accompanying woodcut—the Indian rubber tube is compressed. If, then, the laminae be sawn through, and the posterior arch taken away, the indian rubber tube at once recovers its former shape and dimensions. The spinal marrow is not to be supposed to recover itself with the resiliency of Indian rubber, but the experiment illustrates, in a simple way, what the operation hopes

to accomplish by removing the counter-pressure. Case II. proves that the expectation may be in some degree realized.

One of the questions which Cline proposed to himself before undertaking to trephine for fracture of the spine was whether a patient could recover from a compound fracture of the spine; and later writers upon the subject seem to question the possibility of it. Louis' case, however, shows that such cases are not necessarily fatal.

CASE III. (Louis' Case).^a—M. de Villedon, captain in the regiment of Vaubecourt, received a gunshot wound in the back, when turning to load his gun, at the battle at the bridge of Aménébourg. He fell on the spot, and finding himself paralysed in the lower limbs, he believed that he was mortally wounded. He did not wish to be removed from the place where he fell; but in spite of his entreaties he was conveyed to the hospital at Marbourg, where he was first attended to by M. Duplessis, Surgeon-major. Louis did not see him until the third or fourth day after the injury; M. Villedon was then in a very precarious state, suffering from high fever. It was necessary to introduce a catheter several times a day. He had been bled; the wound enlarged, and the ball extracted. Louis introduced his finger into the wound, and there felt some fragments of bone of considerable size. Louis then says:—"I consulted with my colleague M. Duplessis. He agreed with me as to the imminent danger of the patient, whom, indeed, he believed beyond the reach of aid. I recounted to him the cases of fracture of the spine which I had seen, and the causes of the fatal event which had followed. We drew a parallel as to the mode of treatment of wounds of the head, where one does not hesitate to remove fragments of the cranium which prick or compress the dura mater; we also spoke of the indication for the trephine, even without fracture, to give exit to blood, or matter, or even to prevent suppuration in some cases of fracture. I owe it to the memory of M. Duplessis to say that in this conference our way of thinking was the same.

"The wound was carefully dressed next day; and the spinal marrow having been set free from pressure, and the wound no longer irritated by the fragments of bone, an abundant suppuration became established. The patient appeared better from day to day. The lower extremities recovered their sensibility and some power of movement. Excoriations, the precursors of bed-sores, got well; in

^a Archives Générales de Médecine, série 2, Tom xi., 1836, p. 417.

fine, M. Villedon recovered. For a long time he could only move about on crutches. He made a journey to Barege; he enjoyed good health, and was at last able to walk with a stick. The lower extremities continued weak, and did not recover their original *embonpoint*, one leg being more atrophied than the other. Quoi qu'il en soit c'est une victime que l'art a soustrait à une mort certaine."

The cases hitherto detailed are, to say the least, calculated to encourage surgeons to follow a bolder line of practice than has been hitherto generally adopted in the treatment of injuries of the spine with pressure on the cord. When it is borne in mind that the mortality from fracture of the spine is so great as to have induced Sir Astley Cooper to say, that to save one life in a hundred would be more than he had seen accomplished by surgery; and when, at the same time, we remember that with the aid of chloroform we are justified in undertaking operations, one of the great arguments against which, in former times, was the suffering entailed by the operation itself, such considerations should embolden surgeons to give a further trial to a proceeding which is not more formidable than many of the recognized operations in surgery.

In forming a judgment on so important a question surgeons will, very rightly, be much influenced by their individual experience. Some who have been more fortunate than their fellows in meeting with cases of recovery when they had reason to believe that the spine was fractured and the cord compressed, will be opposed to the proposed operation. Those, on the other hand, who have met with none but fatal cases, and who retain a lively recollection of the dreadful course of suffering through which such cases pass on the road to death, will be more willing to have recourse to an expedient the results of which for so far are, as I say, encouraging.

In my own experience of cases of fractured spine left to run their own course, I have met with but one in which life was preserved. The case is worthy of being recorded, although not bearing exactly upon the present subject, inasmuch as I conceive that the fracture was below the termination of the spinal marrow, and consequently the symptoms arose from pressure and injury to the cauda equina, not from pressure on the cord itself.

CASE IV.—Henry Dalton, formerly a private in the 19th Hussars, twenty-six years of age, was brought under my notice in May last, by Dr. John A. Byrne, physician to the Canal-street

Dispensary. Dalton, who is a remarkably intelligent young man, gave me the following account of his case. Three years ago, when in India with his regiment, his horse, in rearing, fell upon him; as soon as he was disengaged from the weight of the horse he tried to crawl away, but found he could only attempt to do so with his hands and arms, as his legs were totally powerless; in fact he did not feel that his lower limbs were there. He was conveyed to the hospital at Cawnpore, where the surgeon told him that his spine was broken, low down. He was found to be quite paralysed both as regards sensation and motion in the lower limbs; he required the catheter to be used in order to empty the bladder, and he was unable to control the evacuations from the bowels. Apparently some attempt was made at this time to remove, by extension, the deformity of the spine which then existed; for the patient says that he was put under the influence of chloroform several times for some such purpose. His own regiment having left Cawnpore he remained there in hospital for over eight months, under the care of Dr. Meyers of the Royal Artillery, who appears to have devoted very great attention to the case. During this time he regained no power over the lower limbs, neither did sensation improve; he required the constant use of the catheter. No bed sores formed.

His present state is as follows:—

Right leg quite devoid of sensation as high as the knee; obscure feeling of contact of the hand in the thigh, in which, however, he can distinguish the difference between heat and cold distinctly; left lower limb totally devoid of feeling from the groin down.

He can raise the right lower limb by the muscles acting on the upper portion of the femur; the muscles of the leg on the same side are completely paralysed. Muscular paralysis of the left lower limb may be said to be quite complete. Muscles on both sides much wasted. No reflex phenomena can be excited in the lower limbs.

Bladder and bowels are not under the control of the will. He has learnt to introduce a catheter for himself when necessary; urine generally neutral, sometimes alkaline and cloudy with pus. Bowels generally constipated, acting about once a week. When necessary to use aperient medicine he takes sulphate of magnesia in preference to anything else. He desires, however, that the bowels shall be constipated, as he cannot control the evacuations if anything like diarrhoea comes on.

He has *referred* sensations of formication in the right foot. The

temperature of feet and legs is normal; he looks well in the face, and says that his general health is on the whole good.

On examining his back (of which I have a cast in my possession) the amount of deformity taken in connexion with the history and symptoms, leaves no doubt as to fracture of the spine having taken place. The summit of the most projecting spinous process is exactly two inches above a circle made round the body, at the level of the umbilicus, so that we may presume that it is the third lumbar vertebra which has been broken.

This patient passed blood in the urine for some days after the accident, and still suffers occasionally from pain in the left kidney.

This case is certainly one of interest and importance; yet even if it was clear that in this instance the medulla itself had been injured, such cases would not be sufficient to establish a rule never to be deviated from. It might as well be argued that because instances are recorded of compound fractures of the cranium, with depression of bone, recovering without any attempt having been made to elevate the bone, in no such case should an attempt be made to elevate.

Some persons appear to think that if the spinal medulla has been for a time subject to compression it undergoes some structural change, so that even if relieved from pressure it cannot again resume its functions. Physiology has proved that this is not so; but, moreover, we see, not at all unfrequently, cases of spinal disease in which matter outside of the theca pressing on the cord produces paralysis, and after a time the purulent deposit changing its position or making its exit, the cord recovers, and the paralysis more or less completely disappears.

CASE V.—J. M'D., a woman about forty years of age, was admitted to the hospital of the Mountjoy (Female) Convict Prison on February 2nd, 1861. She complained of stiffness in her neck, and had obscure symptoms, leading to the supposition that there existed disease of the cervical vertebræ. On the night of June 23rd she became paralysed; on the following morning I saw her along with my colleague, Dr. Banon. The patient was then totally paralysed, as regards sensation and motion in both arms; in the lower limbs she could feel the contact of the hand when rubbed over the surface, and had a good perception of heat and cold, when vessels containing hot or cold water were applied to the skin; she could not draw up the legs as she lay in bed.

Reflex movements were with difficulty excited in the lower limbs, on tickling the sole of the foot, &c., but no such phenomena could be excited in the upper extremities.

She could not voluntarily evacuate either the bowels or bladder; the former were relieved by enemata, the latter by the introduction of the catheter.

She was perfectly intelligent, and her memory was unimpaired; her speech unaffected; she could swallow without difficulty, and complained only of pains in the lower limbs.

The patient continued in this state for some days. On the 2nd of July, she suddenly underwent a remarkable improvement; she found that she could draw up her legs in bed; she sat up, and fed herself with her right hand; this she could do while she looked at her hand; but if she looked away the spoon fell from her hand; she then did not know whether it was in her fingers or not. She now drew attention to a tumour, in the back of her throat, which had suddenly made its appearance, and caused her such difficulty in swallowing that she could only get down fluids. This tumour could be felt low down in the back of the pharynx.

The patient got weaker, and gradually sank, exhausted, on April 15th.

At Dr. Banon's request I made a *post mortem* examination.

The brain was healthy; and, on removing the spinal marrow, no pus or other evidence of inflammation was found within the theca. For the length of two inches the spinal cord, at the level of about the fourth and fifth cervical vertebræ, was found somewhat flattened from compression. It appeared to the touch to be softened at this point, but this was only apparent softening from mechanical pressure, for careful microscopic examination showed that the structure was not altered. A considerable quantity of purulent matter existed between the theca of the cord and the bodies of the fourth and fifth cervical vertebræ; and this collection of matter was found to communicate with the tumour felt in the pharynx, which proved to be an abscess at the back of the pharynx and œsophagus.

It appears, in this instance, that the pressure of the matter, formed behind the bodies of the vertebræ, flattened the spinal marrow, and interrupted its functions; yet, when the matter made its way forward to the back of the pharynx and œsophagus, the cord in a great degree resumed its functions; and when the patient died, a fortnight later, no structural change had taken place from which it might not have completely recovered.

In the following case also the cord seems to have recovered itself from the effects of pressure, also resulting from formation of matter outside the theca.

CASE VI.—John M'C., 26 years of age, was admitted to the hospital of the Mountjoy Prison, on July 14th, 1865, having commencing caries of the spine, in the lower part of the dorsal region. He became gradually paralysed in the lower limbs, bladder, and rectum. Later, a psoas abscess made its appearance in the left groin; it pointed, and burst. The patient recovered power over the sphincters, and by degrees was able to walk. He left hospital on October 23rd, 1865.

As showing, however, the effects of pressure from a mechanical cause on the spinal marrow, and its capability of resuming its functions when this pressure is removed, the following remarkable case is of paramount interest.

For this case I am also indebted to my friend and colleague Dr. Banon.

John Whitethorn, aged nine years, was admitted to Jervis-street Hospital on July 5th, 1862. He had been playing with some other boys, when he met with a singular accident. The game consisted in running tilt with an old umbrella at a mark upon a wall; as Whitethorn ran forward to strike the mark he was pushed from behind by another boy—one of the wires of the umbrella (one of those which crosses from the sliding ring on the handle to the ribs), being loose, entered the boy's mouth, and was driven through the left side of the soft palate, and into the spine, with force so great as to fix it in it firmly, and snap it across.

Dr. Banon happened to be in the wards at the time when the boy was brought in. He found that the wire had passed through the velum on the left of the middle line, and that it was driven backwards, probably between two of the cervical vertebræ, so as to injure the spinal cord; the wire was not broken off short, but could be seen and caught hold of in the mouth.

The boy's left arm was paralysed, as regards motion, but its sensation was unimpaired; his pulse was 75, weak, and intermittent; there was no paralysis of the bladder, bowels, or lower limbs. It required considerable force to withdraw the wire. At ten o'clock that night the pulse had risen to 112; he could move the left arm, but could not raise it off the bed.

There was fever, with delirium and sickness of stomach for some days; on the 18th the paralysis had almost disappeared—he could extend the arm perfectly from the shoulder.

Later, cerebro-spinal meningitis supervened; then came on severe pains in the neck, followed by vomiting and great restlessness. On the 15th he was roaring with pain, and could not bear to be touched. He became insensible, and died on August 18th, forty-four days after the accident.

The *post mortem* examination revealed considerable effusion at the base of brain, and evidence of meningeal inflammation around the pons, medulla oblongata, and spinal cord. I examined, along with Dr. Banon, the seat of the injury. The track of the wire was followed, as it pierced the intervertebral substance between the third and fourth vertebræ—it had evidently pushed the theca before its point—which was not sharp—and pressed it on the cord, squeezing the latter; the wire had not perforated the theca vertebralis.

Yet, from an injury such as this, the cord recovered itself so quickly when the wire was withdrawn that the same night motion began to reappear, and within a fortnight paralysis had almost totally disappeared.

There is no doubt, as is urged by those who are altogether opposed to the operation of trephining the spine, that it is a general fact that the fragments of the broken vertebræ, which commit the greatest injury to the cord, are usually in front—not behind; and this, as I have already said, seems to be the gravest of all objections which have been offered against the operation; this objection I have attempted to answer in my former communication. I would now merely add that those who put it forward take little or no account of the cases of fracture of the spine, in which the posterior part of the vertebra is broken, and the spinal marrow pressed upon by a portion of bone actually capable of removal. Although such cases may form but a small proportion of the whole number of fractures of the spinal column, yet the records of surgery show that they are, at least, too frequent to be passed over in silence; they are obviously the cases most favourable for the so-called operation of trephining; and a perusal of some of those, which I have here collected from various journals, will, I think, show that among the recorded cases of fractures of the vertebræ there are a good many in which it would have been good surgery to have performed the operation in question

The following cases are intended merely to illustrate the fact that the posterior portions of the vertebræ may be broken, yet the bodies escape fracture or displacement more frequently than some persons would have us believe.

CASE VII.^a—On the 1st of May, 1851, during a violent storm of wind and rain, a balustrade fell from the top of a high building, striking a man, named John Larkin, who was about forty years of age, upon the back of his head and neck. He fell to the ground instantly, and did not again move his feet or legs, although he never lost his consciousness, until he died. I found his bladder paralysed also, and his left arm; but his right arm he could move pretty well. He conversed freely up to the last moment, and said that he was suffering a good deal of pain, which was always greatly aggravated by moving. His death took place 36 hours after the receipt of the injury.

Dr. Hugh B. Vandeventer, who was the attending surgeon, made a dissection on the following day in my presence, which disclosed the fact that the plates of the sixth cervical vertebra were broken upon each side, and that the spinous process, with a small portion of the arch attached, was forced in upon the spinal marrow. There was no blood effused, or serum at this point, but about one ounce of serum was found in the cavity of the tunica arachnoides, at the base of the brain. The bodies of the vertebræ were not broken. It was our opinion, therefore, that the immediate cause of his death was the direct pressure of the spinous process.

CASE VIII.^b—A somewhat similar case to the foregoing is recorded by C. J. Weigel. The patient, sixty-eight years of age, fell from a tree and sustained several injuries. He had complete paralysis of the lower limbs immediately after the fall, but the arms did not become paralysed until the following day. Swallowing was attended with effort, and respiration laborious. He died on the second day. The spinous process of the sixth cervical vertebra, with a piece of the arch on each side, was found to be fractured.

CASE IX.^c—W. J. Thomas, of Liverpool, has reported the case of a woman, forty-one years of age, who met with a fracture of the

^a Hamilton—*Fractures and Dislocations*, p. 150.

^b Weigel and Ammon's *Monatschrift*, Bd. i., 1838, p. 633.

^c *Monthly Archives of Medicine*, Vol. i., p. 408.

spine in consequence of falling down a flight of stairs while intoxicated. She died on the fourth day after the accident.

“The arch of the fourth cervical vertebra was fractured at the base of the spinous process. The wing of the right arch was tilted under the spinous process of the third vertebra, and there firmly wedged.”

There was no fracture of the bodies, but a separation to some extent, between those of the fourth and fifth cervical vertebræ. On opening the membranes there was no effusion, nor were there any marks of inflammation.

CASE X.^a—George Jones, aged thirty-two, a large muscular man, was admitted into Rahere's Ward, St. Bartholomew's Hospital, on the night of the 13th June, 1830, with complete paralysis, and loss of sensation of his lower limbs and trunk, as high as the middle of his sternum; his pulse was 76 and soft, countenance calm, intellect perfect, temperature of the lower extremities natural, partial priapism, respiration performed wholly by the diaphragm, but without difficulty. The previous afternoon, whilst driving rapidly a light cart with two men in it, and endeavouring to restrain the horse, the reins broke, and he fell towards the ground, the wheel passing over the back part of his neck; he was stunned, and on recovering found the lower part of his body paralysed. The patient died ten days after the injury. The arch of the sixth cervical vertebra was found fractured. There was slight separation between the seventh and eighth vertebræ. The external appearance of the cord was natural; but on section the medullary matter was found softened. The viscera of the thorax and abdomen were natural.

CASE XI.^b—J. S., aged 30 years, was injured August 18th, 1850, under the following circumstances. Being engaged in a playful scuffle, he seized his antagonist by the leg, and was in the act of pushing him over backwards; and while in a stooping posture he received a sudden twitch which threw him forwards with considerable violence, the head being flexed upon the chest in such a manner that he struck upon it, and then keeled over. All present agreed that he could not have received any direct blow upon the neck, as the ground was quite smooth. He immediately found

^a Stafford—*Treatise on the Spine*, p. 102.

^b Ladd.—*Boston Medical and Surgical Journal*, 1852.

himself perfectly helpless. I saw him about three hours after the injury; there was complete paralysis and anesthesia of the body and limbs. He complained of pain through the lower part of the cervical region, extending to the top of the shoulders. There was extreme pain on pressure, but no crepitus or deformity could be detected. On the following morning febrile action set in briskly. It was necessary to introduce a catheter to relieve the bladder, and the bowels acted involuntarily. In a few days the urine became alkaline and loaded with mucus; afterwards purulent, bloody, and very offensive. During the first forty-eight hours he regained the power of slight voluntary motion in the forearm, after which there was no improvement whatever in motion or sensation. In about ten days the fever, for the most part, subsided; the tongue cleaned, and appetite returned, but his flesh wasted rapidly; in fact the vital powers seemed to be slowly but steadily giving way. He now began to get paroxysms of dyspnea, and these became more frequent, until he sank at last, exhausted, thirty-six and a half days after receiving the injury.

Post mortem examination ten hours after death.—The six inferior cervical vertebræ were removed entire, when it was found that the spinous process of the fifth was fractured through the laminæ, and pressed down upon the cord. The fragment was with some difficulty removed, in consequence of the inequalities of the broken surfaces. The cord appeared much flattened, the membranes were entire; on opening the theca the cord was found to be of the consistence of cream at the seat of injury; below this slightly softened.

CASE XII.^a—Joseph Feugré fractured his spine by a fall on his back from a height of about fifteen feet. Five days after the accident he was admitted to the Hospice de la Magdeleine at Rouen. The lower limbs, bladder, and rectum were paralysed.

He died fourteen days after the accident. A portion of the spinous process of the third dorsal vertebra was detached; a fissure passed through the laminæ of the fourth; a considerable effusion of blood occupied the spinal canal.

CASE XIII.^b—Patrick Gallagher, collier, aged thirty-seven, while at work in a coal pit a large stone fell from the roof, struck

^a Histoire de quelques affections de la colonne vertébrale, par Alexandre Demussy, p. 6.

^b London Medical Gazette. Vol. ii., for Sessions 1843-4, p. 359.

him on the back, and crushed him. Entire loss of motion and sensation below the seat of injury; retention of urine.

Death seventeen days after the accident.

“Upon removing and sawing the injured part of the spine through the centre from back to front, the intervertebral cartilages between the eighth and ninth dorsal vertebræ were found wanting, having been destroyed by absorption or ulceration. The surfaces of the same vertebræ were bare, soft, and soaked in pus. There was some extravasation between the membranes within the sheath of the cord, and the latter was much compressed and lacerated by a small, thin, pointed fragment of bone, which had been detached from below the base of the spinous process, and driven inwards.”

CASE XIV.^a—M. Chappillon met with a case in which a bookseller, M. Duchesne, was injured by a pile of books falling upon him from a height of twenty feet. The patient died sixteen hours after the accident. The spinous processes of the second, third, fourth, and fifth vertebræ were found to be fractured and separated from their bodies; but these latter were not displaced; the fibro-cartilages uniting them only, appeared to be more relaxed and movable than they usually are.

CASE XV.^b—Ekstroemer, of Stockholm, has recorded a case of a miller who received a severe injury of the spine in the cervical region by falling headlong from his mill; he had paralysis of the extremities, and of the sphincters, &c., with diaphragmatic respiration.

The spinous processes of the fifth, sixth, and seventh cervical vertebræ were found to be broken, and pressed in upon the medulla.

CASE XVI.^c—Mr. Belcher, of Burton-on-Trent, reports the case of a man, thirty-seven years of age, a sawyer, who fractured his spine by falling backwards from a cart on which he was standing, so that the vertex seemed first to strike the ground.

^a Archives Generales de Médecine, 1836. Tome xi., p. 421. M. Louis, who reports this case in this very remarkable memoir, read to the Academy of Surgery on April 18th, 1774, makes the following observations on it:—“Cette blessure a dû paraître audessus des ressources de l’art; cependant dans un accident aussi fâcheux et tout-à-fait désespéré que risquerait-on a pratiquer une incision par laquelle on pénétrerait jusqu’aux apophyses fracturées, pour débarrasser la moelle epinière des esquilles qui la blessent, et donner issue au sang épanché?”

^b Zeitschrift für d. gesamt Medicin. (Hamburger.) Band xiii., 1840, p. 408.

^c British Medical Journal, 1862, Vol. ii., p. 531.

He died on the fifteenth day.

The spinous process of the first dorsal vertebra was splintered, and a portion detached. The articular processes of the first and second dorsal vertebræ were fractured, and their capsular ligaments torn; the arches of the vertebræ separated to some extent. There was no dislocation or fracture of the bodies of the vertebræ.

CASE XVII.^a—Schallenmüller also gives a case in which the spinous process of the sixth cervical vertebra and the laminae on each side, at their union with the transverse processes, were broken, the body escaping without fracture or displacement.

CASE XVIII.^b—Louis mentions a case in which the spinous and transverse processes of the sixth and seventh cervical vertebræ were broken without fracture or dislocation of the bodies.

CASE XIX.^c—Boyer narrates the following—"A sack of flour weighing three hundred pounds, fell on the nape of the patient's neck; an acute pain was felt in the lower part of the cervical region. The patient was conveyed to the Hospital of La Charité. On examining him I perceived that the spinous process of the seventh cervical vertebra was more prominent than in the natural condition. The upper and lower limbs were paralysed; respiration laborious; the rectum and bladder incapable of acting. The patient died at the end of five days. At the *post mortem* examination we found a fracture of the posterior arch of the seventh cervical vertebra, with depression of a fragment which pressed on the spinal marrow, and exercised upon it firm compression."

CASE XX.^d—Professor Weber, of Bonn, records the following case.

A patient, forty-six years of age, was precipitated down a staircase, with a sack on his shoulders, and was immediately brought into the "Klinik," paralysed. Between the fourth and sixth vertebræ of the neck there was to be felt a hollow which could not be removed by cautious stretching of the neck. There was complete paralysis both of sensation and motion of the lower limbs, the

^a Medic. Correspondenzblatt (Wurtemberg), Band 13, 1843, p. 364.

^b Archives Generales de Med., 1836, Vol. xi., p. 412, Case v.

^c Traité des Maladies Chirurgicales. Third Edition. Vol. iii., p. 137.

^d Chirurg. Erfahr. und Untersuchungen. Berlin, 1859. Page 164.

bladder and rectum. The urine was drawn off by the aid of the catheter. On the following day the upper extremities also were paralysed, and the patient died fifty hours after the accident. The arch of the fifth cervical vertebra was broken and dislocated so as to compress considerably the spinal marrow. Some inflammation of the membranes extended upwards to the cranium.

CASE XXI.^a—Mulder mentions the case of a man aged thirty-eight years, who, from a fall backwards on the ground, fractured the spinous processes of the fourth, fifth, and sixth cervical vertebræ. The bodies were not broken, but the posterior arches were broken into several fragments. The patient lived two days.

CASE XXII.^b—Jaeger reports a case in which the spinous process of the sixth cervical vertebra was fractured by a waggon laden with wood passing over a man's neck. There was no trace of injury done to the skin, but there was great tenderness over the spinous process of the sixth vertebra; the lower limbs were paralysed, and some hours later the arms also. The patient died, convulsed, in eighteen hours. The medulla was torn beneath the fractured portion of the vertebra, and blood was effused within the theca.

CASE XXIII.^c—Mr. Arnott exhibited to the Pathological Society of London a specimen taken from a patient, aged seventy-four years, who died in University College Hospital, on July 30th, 1850. In this case the spinous process of the axis was found broken off, with a portion of its laminae. The broken off spinous process was much depressed below the others, and wedged in between the axis and the vertebra below.

CASE XXIV.^d—This case, reported by MM. Maunoury and

^a R. Stroemer, Ueber d. Bruch der Wirbelbeinforsätze. Wurzburg, 1842. P. 12.

^b Hedinger, Ueber d. Knochenverletzungen, &c. Leipzig, 1833. Page 90.

^c Lancet, 1850. Vol. ii., p. 588.

^d Gazette Medicale de Paris, 1842, p. 361.—The reporters of this case add to it the following observation :—"In Bressant's case there was only a fracture of the vertebral lamina, effusion of blood between the dura mater and the bone, integrity of the medulla. "Dans ces cas, si on pouvait pressentir le peu d'étendue de la lesion, que n'aurait on le courage d'aller à la recherche de la fracture, de détacher la lame osseuse, qui comprime la moelle et qui est la cause infallible d'une mort rapide; il a fallu certainement plus de hardiesse pour appliquer plusieurs couronnes de trépan sur le crane, pour faire le ligature des artères iliaques primitives, et de l'aorte abdominale, pour enlever la matrice en totalité."

Thore, and was one of those met with in the practice of Professor Roux, in the Surgical Clinique of the Hôtel Dieu, in 1841.

Bressant, forty-eight years of age, was brought to the Hôtel Dieu immediately after a fall upon his back from a height of about twelve or fourteen feet. He was stunned, but soon regained consciousness. On admission there was paralysis of sensation and motion, the skin was insensible as far up as the base of the thorax, following a line corresponding with the vault of the diaphragm. The muscles of the forearm were paralysed, respiration diaphragmatic, respiratory murmur normal, pulse quiet, paralysis of the bladder, priapism of which the patient was not conscious.

Death on the sixth day.

There was fracture of the laminae of the fifth cervical vertebra, the spinous process of which was removed with facility. Beneath the fracture there was some black blood between the dura mater and the bone. The medulla was uninjured. There was also fracture of the sternum or separation between the manubrium and body of that bone.

CASE XXV.^a—A Negro, aged thirty, while wrestling with a companion, was thrown suddenly upon his neck, by having his feet tripped from the ground. The fall was immediately succeeded by a loss of motion and feeling in the shoulders and arms, in the walls of the chest and abdomen, and in the lower extremities. Though there was an entire loss of sensibility to the impression of external agents, he was subject to occasional and severe pains in all the paralysed parts, and to constant and lancinating pains in his arms and shoulders. There was no external mark of injury over the spinous process of the fifth cervical vertebra; but a distinct crepitus was perceptible on pressure. His breathing was short and extremely laborious, being carried on alone by the action of the diaphragm. The muscles of the head and neck, above the origin of the phrenic nerve, maintained their integrity. His pulse and the temperature of his body were unaffected until near the close of life, which occurred within forty-eight hours after the accident. On the day subsequent to the injury he was affected with retention of urine and great abdominal distention; notwithstanding the peristaltic action of the bowels had been excited, and met with no resistance from the paralysed sphincter. There was no distention of the corpora cavernosa.

^a American Journal of Medical Science, 1837, Vol. xxi., p. 276.

Dissection.—The rim or arch of the fifth cervical vertebra was fractured in three places, and the spinous process, with a part of the arch, was driven in upon the spinal marrow. There was a slight effusion of blood between the sheath of the spinal marrow and the bone, and a considerable effusion between it and the substance of the cord. There was no material lesion of the medulla or of its investing membranes; and the body of the bone was not fractured or displaced at the intervertebral junction.

CASE XXVI.^a—A. B., a mason, twenty years of age, while going up a staircase with a hod on his shoulder, made a false step and fell backwards; in the fall the posterior part of the cervical region of the spine struck with violence against the corner of one of the steps.

When carried to the Hôtel Dieu the patient presented the following symptoms:—Paralysis of the limbs; insensibility of the skin, which was cold (especially that of the extremities). His respiration resembled that of a man in a troubled sleep; the pulse was very slow (40 to 50 in the minute); slight drowsiness; voice feeble; he was slow in answering questions addressed to him; his eyelids drooped; there was erection of the penis. The walls of the thorax were immovable during respiration which was performed by the diaphragm.

On the day following the accident deglutition was very difficult; respiration more laboured, especially in the evening; every instant the patient was threatened with suffocation. The priapism was persistent.

A catheter was introduced to draw off the urine, without his perceiving it in the least. Dejections passed involuntarily; pulse small, very slow. All the parts below the lesion of the neck were completely paralysed. The patient understood everything, answered correctly what he was asked, and only complained of the painful feeling of suffocation.

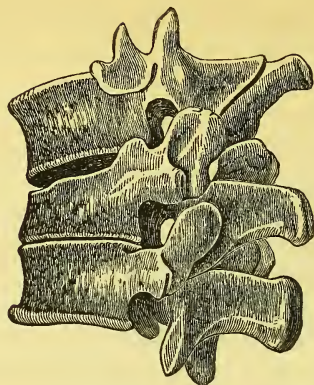
The *autopsy* revealed a fracture, with depression, of the laminæ of the fifth cervical vertebra; the spinal marrow was firmly compressed at the point corresponding, and was reduced to one half its ordinary volume; the substance of the medulla was marked with striæ of blood.

These cases show, if nothing else, at least that instances of fracture of portions of the vertebræ, unaccompanied by fracture or

displacement of the body, are not very unfrequent; in fact, I candidly confess, that until I had looked into the published details more carefully than I had hitherto thought of doing, I accepted the assertions of others, and was not prepared to find so many. Those which I have here brought together represent rather more than ten per cent. of the recorded cases upon which I have been able to lay my hands. In the great majority of such cases the fracture occurs in the cervical or upper part of the dorsal region; the reason of which is obvious both from the conformation of the spine and the exposure of these regions to injuries by direct violence. In discussing the question as to whether the operation of trephining the spine is to be admitted among the legitimate and recognized operations in surgery, injuries of the kind above mentioned have a considerable importance. They prove that after all, among the cases of fracture of the spinal column, a goodly per centag  are of such a nature that even the sternest adversaries of the operation would admit them not to be unsuitable for it. The question here only turns upon the difficulty of diagnosis.

The real question as to the fitness or unfitness of any case for operation will, I conceive, depend far more upon the exact amount of injury done to the spinal cord than on whether the fracture engages the portions of the vertebra in front of it or behind. No doubt the operation would have a good chance of being brilliantly successful in such cases as Case VII., XI., XIX., or XX.; but assuredly there are not a few cases in which, although pressure may arise from injury done to the vertebra anteriorly, yet removal of the counter-pressure posteriorly will set the cord free from being squeezed. When the body of a vertebra is broken, and, as usually happens, the intervertebral substance is at the same time more or less lacerated, the progress of the case must be, under the most favourable conceivable circumstances, very tedious. The first thing that nature does is to absorb the lacerated fibro-cartilage, and while this is being accomplished little or no callus is thrown out. I find, however, a considerable number of cases reported in which the body of a vertebra is so injured as to press upon the marrow, although no separation of it into fragments has taken place; neither are the fibro-cartilages torn. The accompanying woodcut, Fig. 2, shows the appearance in a case of this kind mentioned by Professor Middeldorpf. The body was flattened by compression so as to bulge backwards into the spinal canal. The spinous process of the vertebra above was also broken.

Fig. 2.



The most remarkable case of this kind that I have seen is one which was communicated to the Surgical Society of Ireland, last March, by Professor Geoghegan,^a by whose kind permission I

Fig. 3.

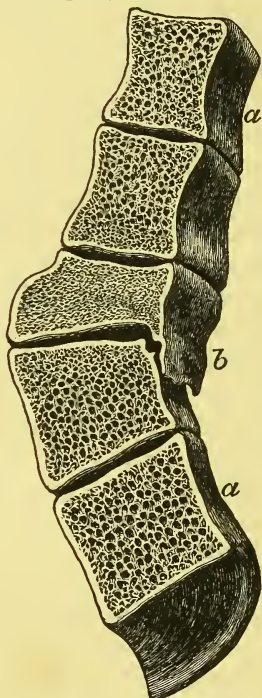


Fig. 3, showing compression of one of the dorsal vertebræ. The bodies of the vertebræ are sawn vertically through the centre, and the section viewed from the anterior aspect, in order to show the exact character of the lesion. *a a*. Front of bodies. *b*. Fifth dorsal vertebra.

^a Medical Press and Circular, March 21st, 1866, p. 277.

obtained a woodcut from the preparation. The patient fell into an area on his head; by the indirect violence thus communicated to the spine the fifth dorsal vertebra was compressed in the manner exhibited in the woodcut, Fig. 3. It was in fact flattened so that it bulged backwards, encroaching on the spinal canal. No portion of the vertebra was actually detached, neither was the fibro-cartilage torn either above or below the compressed body.

In injuries of this kind if, by taking away the posterior arch or arches, the pressure on the cord is relieved so as to enable the patient to escape from the immediate risks to life, there may be reason to hope that the patient may ultimately recover, as do cases of curvature of the spine from caries, where the deformity is as great or even greater.

When, in consequence of a fracture of the spine, the marrow is subject to pressure—but not lacerated—it is usual, unless the pressure be so considerable as to destroy both sensibility and motion below the injury, to find that the functions relating to motion are much more affected than those of sensation; the patient cannot attempt to move his toes or feet; cannot draw up his legs in bed, or even push them down if flexed for him, while feeling may be normal even to the tips of the toes; the sphincters may be paralysed, yet the patient distinguishes the temperature of an enema, and complains on the introduction of a catheter; if the spinal marrow be lacerated to any considerable extent, or what is equivalent to laceration, if it has been so roughly compressed as to disintegrate its structure, the case is different—sensation and motor power are then alike lost.

Between these two supposed conditions there are many degrees; and an accurate examination of the symptoms connected with sensation must be the chief aid in making an accurate diagnosis. The amount of sensibility on one side as compared with the other, and estimated by application of the points of a pair of compasses—the appreciation of the sensation of heat and of cold—of contact, of tickling, and of the position of the limbs—should each be looked to. The amount of voluntary power affecting certain muscles will assist in determining the seat of pressure; and if paralysis of motion is found on one side in a degree much more marked than on the other, while sensibility is observed to be greatest in the part where motor power is least, there need no longer be any doubt that the pressure is chiefly exercised on the lateral half of the cord on that side of the body on which the motor paralysis is found to be greatest.

I have lately seen, with Dr. Darby, of Bray, a case in which the pressure caused by the formation of matter strikingly illustrated this fact.

I am indebted to Dr. Darby for the notes of the case.

CASE.—Pat Byrne, aged eight years, healthy, active, and intelligent, for some months in the school of the Rathdown Workhouse, was brought under Dr. Darby's notice on the 9th of March, 1866, by his father, who said he had observed the boy for some days past holding his head awry; the boy, on being questioned, said he did not know what had brought it on, and added that he had no great pain—he did not mind it; his head was inclined to the right side, and could not be turned straight; in other respects he appeared healthy; he was ordered to hospital, and directed to take a purgative, and have a warm bath; the head continued awry, but his health continued good; he remained in hospital, and had poultices, leeches, and such care in medical treatment (purgatives, &c.), as the case seemed to require, up to the 25th, when he first complained of want of power, and pain in his right arm. On this day his pulse was quick—tongue clean—appetite good; leeches were applied, and such other treatment as appeared necessary.

On the 10th April his right arm was quite paralyzed, and he showed some febrile symptoms, and a fulness was observed in the right side of the back of the neck.

On the following day I saw the boy along with Dr. Darby. The patient could not make the faintest attempt at moving his right arm, or stir any of the fingers; he could move the left arm freely about, and grasp tolerably firmly with the hand; as to feeling—the symptoms were reversed; in the left hand he could hardly feel at all, so that when the tops of the fingers were tightly pinched he did not wince, while the slightest pressure on the fingers of the right caused him great distress; at this time both sensation and motion in the lower limbs were unimpaired. The opinion formed was, that a deep-seated abscess, possibly connected with diseased bone, was pressing on the right side of the spinal cord in the cervical region. He became worse, and died on May 4th.

An abscess was found to exist, pressing, as had been supposed, on the cord; this collection was partly external to the spinal canal—partly within it; the pus escaped when the vertebræ were being removed; from an examination of the cavity it appeared that, external to the theca, and between it and the bone on the right side,

there had been a collection of matter of about the size of a small filbert; this communicated with a larger cavity external to the canal, situated anterior to the transverse processes, and very deep among the muscles of this region.

In seeking to excite reflex movements in the lower limbs of patients suffering from fractured spine the observer is often disappointed in being able to do so, and this too, when the injury is so high up as to lead one to suppose that the lower portion of the cord is intact. Some persons, for whose opinions I entertain the highest respect, regard the absence of the capability of exciting reflex movements in such cases as a proof that the injury is not restricted to a local compression of the cord, "but that it involves also such a molecular disturbance of its structure as appears to be propagated throughout the entire segment of the organ inferior to the direct seat of mischief." Were this view correct, it would appear that a total absence of reflex movements in the lower limbs would indicate an extensive lesion of the medulla, not possible to be removed by getting rid of all pressure at the seat of injury. As I believe, however, that there is another and very different explanation to be offered concerning this symptom (or rather absence of a symptom), I may be pardoned for stating what I conceive to be the true physiological solution of the problem.

When a patient is suffering from inflammatory softening of the spinal cord in the middle of the dorsal region, or higher up, energetic reflex movements can always be excited in the lower limbs by tickling the soles of the feet, plucking the hairs on the inside of the thigh, and so forth. In short, when by disease the lower portion of the spinal marrow is cut off more or less completely from communication with the sensorium the portion so cut off retains its power of giving rise to energetic movements when excited, so as to call its reflex action into play.

What is then the reason that this does not also happen when, by a fractured or displaced vertebra, or pressure from any cause, the lower portion of the medulla is cut off from communication with the sensorium. It must be remembered that in cases of paraplegia dependent on congestion of the spinal cord or its meninges, it is usually difficult and very often impossible to excite reflex movements, and that this constitutes one of the most important diagnostic marks of this form of disease. If, therefore, any mechanical cause gives rise to congestion of the cord, it is reasonable to suppose that a similar state of things will be found to exist.

It is therefore simply venous congestion of the cord, resulting from pressure at the seat of injury, and not a molecular change pervading its whole structure, that causes the possibility of exciting reflex motions to be in abeyance. If this view be correct, so far from being a reason against the operation, the absence of reflex movements is an additional indication of the necessity of, so far as possible, getting rid of mechanical pressure on the cord.

In support of the accuracy of this view it may be mentioned that in injuries affecting the lower portion of the cord it may be found impossible to excite reflex movements in the feet, toes, or muscles of the calf, while stimulation of nerves, whose roots enter the cord above the seat of injury will call forth energetic movements in the sartorius, cremaster, &c.; moreover, if these movements are excessively active it may, along with hyperesthesia of the surface, be taken as evidence that the cord immediately above the injured part is in a state of vascular excitement, tending to inflammation of either the cord or its membranes.

So far as is at present known, the occurrence of priapism does not appear to yield any special information, either as to the precise portion of the marrow injured or the amount of pressure exercised on the cord. It seems to give evidence of excitation of the upper part of the cord, and nothing more. Priapism is mentioned as having taken place in about thirty per cent. of the cases collected by Gurlt, in which the injury occurred above the second dorsal vertebra; when the injury to the cord is lower down it is of much rarer occurrence; and even then, I suspect, is really produced by an excitation of the marrow above the injured part. It is a symptom which is usually transient, seldom lasting more than a day or two, although in some cases persisting for a fortnight, or even longer.

The remarkable increase of temperature noticed in some cases as occurring in consequence of injury of the spinal cord, does not any more than the occurrence of priapism, appear to indicate the exact part injured, or the amount, or nature of the injury. Indeed, it is greatly to be regretted that the cases in which this phenomenon has been noticed have not been more carefully investigated. Sir B. Brodie mentions a case in which the thermometer rose to 111° F., when the bulb was placed between the scrotum and the thigh; he does not state what the temperature was above the injured part. Mr. Butcher, in the account given of his case of dislocation of the cervical vertebræ, without fracture, states that the heat in the

lower limbs was absolutely greater than natural. What the temperature was either above the injury or in the lower limbs, is, unfortunately, not stated. To have proved that the blood circulating in the paralyzed parts was absolutely so many degrees warmer than that in the parts above the injury would have been most interesting ; it is also to be regretted that among the symptoms noted concerning the same important case no mention is made of the capability of exciting reflex movements in the parts below the seat of injury.

The examination of the spinal column itself at that part where the lesion has taken place may naturally be expected to give much information as to the degree of benefit which may be hoped for from the operation of trephining. The amount of deformity, the degree of tenderness, and general tumefaction—the possibility of detecting crepitation or displacement of the spinous processes will each indicate something in favour of the operation, or the reverse, according to circumstances. The nature of the injury and the exact mode in which the accident happened should be carefully inquired into. It is only necessary to read some of the cases already quoted to see that the close investigation of the precise circumstances of the accident may yield evidence which, taken in connexion with existing symptoms, will aid more than anything else in forming an accurate diagnosis as to the exact nature of the lesion.—(See cases VII. and XXVI.)

If, before the operation be undertaken, there is evidence that myelitis or meningitis has already supervened, it is obvious that little benefit could be expected from the performance of it. If, therefore, the patient complains of the well-known symptoms of feeling as if a cord were tied round the body at the limit of the paralysis, and formication, and "*pins and needles*," not only in the parts still sensitive, but where sensation has been already lost ; if there are cramps and spasmodic twitchings in the feet, calves, or abdominal muscles, and if, at the same time, there is an accession of fever, quick pulse, &c., accompanied with excessive sensibility of some portions of the surface, operation need not be contemplated ; if it is to be done with a reasonable prospect of success, it must also be undertaken before those changes have taken place which give rise to atrophy of the muscles, bed sores, alkaline, and muco-purulent urine, &c.

There appears to be nothing to contraindicate the free use of chloroform during the performance of the operation. It was administered so as to produce its full effect in the case operated on

by myself, in Dr. Gordon's case, and in a third case in which my colleague, Dr. Henry J. Tyrrell, lately performed this operation in Jervis-street Hospital. In all these cases the injury to the spine was low down; although the patients were turned over so as to lie on the front of the body, there was no difficulty experienced in giving it. In Jones's case, where the injury was high up in the dorsal region, and the action of the heart was intermittent, the patient was nevertheless placed under the influence of chloroform, on two occasions, without bad result—once for the purpose of minute examination, and a second time for the operation.

A very considerable number of the recorded cases of fractures of the spinal column show that after death softening of the medulla has been observed at the seat of injury. My own observations, as well as those of others, have convinced me that in many instances this softening is something different from inflammatory softening on the one hand, and white or atrophic softening on the other. In both, inflammatory and ordinary white softening, it is probable that the nervous tissue has undergone a structural change from which it cannot recover. In that kind of spurious or mechanical softening which the cord undergoes from the pressure of purulent matter, bone, &c., it is quite certain that it can recover; it has undergone no structural change which prevents it, as soon as the removal of pressure permits the circulating fluid to permeate it, and nourish it once more, from recovering itself and resuming its functions. It probably best bears comparison with that kind of atrophic softening which may result from embolism, and which may, if the collateral circulation be so re-established as to restore nutrition to the part, be followed by recovery.

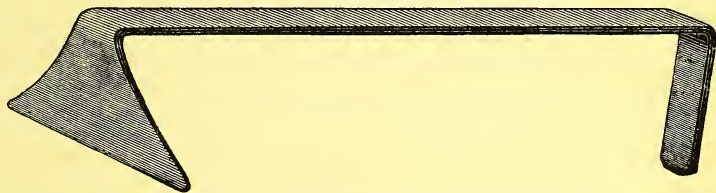
In Cases II. and V. I examined the structure of the medulla with great care, but without finding either exudation granules, or traces of fatty degeneration. The medullary substance was bloodless from pressure, and nothing more; when the finger was passed down gently along the cord, at the part which had been compressed, it felt softer; and when moved between the fingers it felt more limp at that part, yet the microscope gave no evidence that any structural change had taken place. We must not, therefore, suppose that in all the published cases in which softening is said to have occurred that myelitis had taken place.

I have now seen the operation performed three times on patients, and I have performed it many times on the dead subject. The mode of its performance, and the difficulties which are encountered

in accomplishing it, vary much in the different regions of the spine, and, of course, in actual practice must vary with the nature of the case and the mode of injury. When the spinous process and laminae only are broken the whole proceeding will be very simple; but even when this is not the case it may be said, that compared with many of the great operations in surgery, that of trephining the spine is not so formidable as has been supposed.

In the lumbar region and lowest part of the dorsal the operation offers the greatest difficulties. The patient should be placed face downwards, with the feet towards the window, so that the light may fall into the bottom of the wound. The body should be placed as evenly and flat as possible on its front aspect; but the person who gives chloroform can keep the head turned a little on one side, and somewhat raised, by placing one of his hands under the chin. An incision from four to five, or six, inches long is to be made through the integuments over the spines, with a strong scalpel. A strong curved bistoury is the best instrument with which to divide the muscles on each side of the spinous processes; and this can be done, at once, more rapidly, and closer to the bone, by entering the point of the bistoury below and cutting upwards and backwards. As soon as the mass of muscles on each side are to a sufficient extent divided, the operator should fix, himself, on each side, a retractor such as is here represented, Fig. 4, and give each in charge to an assistant.

Fig. 4.



The broad flange of such a retractor not only keeps the wound well open, so that the operator can see what he is about, but by pressure prevents hemorrhage, while the hand of the assistant who holds it does not get fatigued, owing to the other end being bent. The operator should next feel in the sulcus, on each side of the spinous process, for the inequality caused by the injury, and by grasping successively each spinous process, in a pair of necrosis forceps, ascertain whether the posterior portions of any vertebra are broken. He must then determine which laminae are first to be divided; and before doing this it is well to place sponges, wet with iced water, in the hollows on each side of the spinous processes, and give time for all hemorrhage to cease.

Having singled out the spinous process of the vertebra, the laminæ of which are to be divided, the interspinous ligaments above and below it are to be cut, and a part of the process taken off, with bone forceps, leaving, however, enough to grasp with the necrosis forceps, when it becomes necessary to remove that portion, after division of the laminæ. The division of the laminæ, in this region, is exceedingly difficult. The trephine cannot be used; and Hey's saw, owing to the depth of the wound, and oblique manner in which the bone must be sawn, is also useless. The division is best accomplished by strong forceps bent at an angle, something like the forceps known as "Fergusson's side-cutting forceps." Experience shows that the laminæ may be thus cut through without fear of injuring the cord or its membranes. As soon as this has been accomplished, the portion of the spinous process still remaining is to be caught in a pair of necrosis forceps, and the portion of bone raised and removed by carefully dividing the ligamentous structures still holding it. When the posterior arch of one vertebra has been taken away, the removal of the second is comparatively easy; the best method of effecting this is by nibbling it away bit by bit, with the ordinary gouge forceps.

It is a much easier matter to remove a spinous process, and the laminæ on each side of it, in the middle or upper part of the dorsal region than in the loins. In its preliminary stages the operation is like the foregoing. When the muscles on each have been divided and retracted, as already described, owing to the mode in which the spinous processes of the dorsal vertebræ are imbricated one over the other, it becomes necessary to remove the spine above that which, with its laminæ, is to be first taken away. This having been done the spinous process of the vertebra, the laminæ of which are to be divided, should be taken away, as close to its root as possible, with gouge forceps. With a little care the spinous process can be so completely taken off as to leave the surface sufficiently flat for the application of the crown of a trephine, which should in general be about one inch in diameter, and furnished with a strong centre pin, a little longer than usual. As the bone is of a much softer texture than that of the cranium, the trephine once planted, works rapidly, so that after a few turns the centre pin should be withdrawn, and it should then be worked gently until it is found possible to move, and subsequently elevate, the trephined portion; after this is taken out it will be seen that in the dorsal region there is a sort of provision which enables one to use the

trephine without much danger of its, in any way, injuring the cord. In fact the articulating processes of the vertebra, next below, look backwards in such a way as to prevent the instrument from going suddenly in so as to injure the medulla. The posterior arch of a second vertebra may now be easily taken away, either by a second application of the trephine, or better still, by the aid, simply, of the gouge forceps.

In the cervical region the removal of the bone can be effected with great facility by the gouge forceps alone; here, as well as in operating on the first dorsal vertebra, the trephine cannot safely be employed. After the skin has been divided and the muscles detached on each side the interspinous ligaments are to be cautiously cut, taking care not to sink the scalpel too deeply; the spinous process is next taken off with the gouge forceps, and at once the ligamentum subflavum comes into view, and the vertebral canal is opened to a small extent. Bit by bit the posterior arch is then to be taken away by the gouge forceps, until enough is removed. The removal of a second or third can be even more readily accomplished with the same instrument. The retractors employed for holding back the muscles on the neck should not be so broad as those intended for the operation on the back or loins, and the lower edge of the retracting flange should be somewhat convex.

In all the cases which I have seen the wounds have gone on favourably under the simplest treatment; water dressing at first; and after suppuration has become established, charpie, with simple dressing, or a poultice with some "warm dressing" under it.

It is unnecessary to say that every possible attention must be paid to the general health of the patient. He should be placed on a water bed, the bowels and bladder carefully attended to, and any tendency to bed-sores guarded against with the utmost anxiety. For this purpose he must be shifted from side to side, and occasionally placed upon his back, even at the risk of pain in the wound or disturbance of the broken vertebra. To avoid bed-sores and keep the bladder in good order must be the first object of the surgeon, and no entreaties or complaints should influence him in deferring to do what he considers necessary for this purpose. The bed clothes must be frequently changed, and kept perfectly dry. If any bed-sores have already formed, every effort should be made to get them cured; if the urine is already alkaline and mucopurulent the bladder should be washed out every day, or several times each day.

Immediately after the operation the object of medical treatment should be to avoid inflammation of the cord or its membranes, and with this view belladonna or atropia should be administered, with the intention of keeping the medulla as much as possible in a condition of repose; opium should not be given; but if urgently demanded to allay pain it should be joined with belladonna, in doses proportionally large. Somewhat later iodide of potassium may be ordered, and when all apprehension of inflammation is past, strychnine. Indeed, it will be in different cases a very nice and at the same time very important question to determine whether it may not be good practice to give strychnine early, even at the risk of calling forth inflammatory action in the cord. Of course, its administration would not be contemplated if any tendency to myelitis can be detected. But if pressure on the medulla for a longer or shorter time has given rise to that kind of mechanical softening of it which, without being identical with white or atrophic softening, is closely akin to it, and if it seems that the parts below are not recovering their vital powers after the pressure has been got rid of, it may become necessary to make a desperate effort to rouse the dormant energies of this portion of the marrow, regarding the chance of exciting inflammation of it as the less great danger of the two. Under these circumstances I should not hesitate to give strychnine cautiously before many days after the operation.

Shampooing of the limbs and the use of electricity should be early applied, in order to arrest the atrophy of the muscles. Whatever doubt may exist as to giving strychnine at an early period after the operation there need be none about its administration after the risk of inflammation is past; it should then be added to good nourishing diet, with wine, beer, and iron tonics.

I have alluded in the foregoing pages to a case in which my colleague, Dr. Henry J. Tyrrell, lately trephined the spine, in Jervis-street Hospital. The case will, no doubt, be more fully reported hereafter. I may mention, however, that the patient, a young man twenty-one years of age, met with the injury of the spine three weeks ago; he was operated on forty-eight hours after the accident. During the operation he was thoroughly under the influence of chloroform, and since the operation the wound has gone on admirably. Whether this case may prove successful or not, it cannot be said that the patient's suffering has been materially

increased, or his duration of life in any way shortened, by the operative procedure.

M. Tillaux, surgeon to the Hospice of Bicêtre, has lately reported a case of trephining of the spine, in a paper published in the *Bulletin Général de Therapeutique*, 15th March, 1866. In his communication M. Tillaux makes some very judicious observations on the symptoms which indicate or contraindicate operation in cases of fracture of the vertebral column. One is surprised, therefore, at finding that he himself selected a case eminently unsuited for it. The patient died on the night succeeding the operation, and M. Tillaux himself observes:—"Il est facile de voir par l'observation, que la mort a été le résultat d'une myélite ascendante qui existait déjà, et dont la marche a pu être seulement activée par l'extraction des fragments vertébraux.—Il ne serait pas juste de rendre l'opération responsable du résultat." In this last sentiment most surgeons will concur, and it is to be hoped that others who may look favourably on the operation will not select cases for its performance in which there cannot be the faintest hope of its being successful.

